SPECIFICATION

TO WHOM IT MAY CONCERN:

Be it known that I, George Henry Kerby, with residence and citizenship listed

5   below, have invented the inventions described in the following specification entitled:

HUMIDITY-BASED PRINTER SYSTEM CONTROL

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HUMIDITY-BASED PRINTER SYSTEM CONTROL

Background of the Invention

1. Field of the Invention

5   The invention is related to the field of printer systems, and in particular, to a

printer system and toner cartridge that provide humidity-based control over printing

operations.

2. Statement of the Problem

10   Printer systems include copiers, computer peripherals, network devices, and

other devices that produce copies of desired materials. The quality of the copies are

adversely affected by humidity variation. Unfortunately, the initial configuration of the

printer system may not be optimized for the actual humidity levels that are

experienced in the field.

15   Some advanced color printer systems include internal humidity sensors that

periodically detect humidity levels to control printer operation. Typically, the printer

system re-configures its engine characteristics based on the humidity levels.

Unfortunately, this type of humidity control requires internal humidity sensors that are

only available in advanced color systems. Humidity control is not available in

20   monochrome systems.

        Printer systems use pixels to represent the desired materials. The pixels

have pixel values that specify the shading for a small area of the resulting copy. The

pixel values may be eight-bit codes. The printer system may scan physical material

or process an electromagnetic signal to generate the pixel values. Printer systems

25   use dither matrices to modify pixel values before producing the copies. Some printer

systems periodically adjust the dither matrices based on toner development measurements. Unfortunately, these printer systems do not adjust the dither matrices based solely on humidity.

5 **Summary of the Solution**

The invention helps solve the above problems with a printer system and toner cartridge that provide humidity control in both color and monochrome systems. Advantageously, the printer system adjusts the dither matrices based on humidity to improve copy quality. The humidity control may be exerted in real-time to provide

10 continuous quality control. The printer system does not require internal humidity sensors.

Some examples of the invention include a printer system comprising a communication interface and printer components. The communication interface receives a humidity value from a toner cartridge. The printer components control

15 printing operation based on the humidity value. The printer components may determine a humidity range corresponding to the humidity value. If the humidity value is not available, the printer components may use a default value. The printer components may provide humidity-based control in real-time and produce monochrome copies.
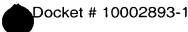
20 To control printing operation, the printer components may configure a dither matrix based on the humidity value. To configure the dither matrix, the printer components may select the dither matrix from a plurality of dither matrices based on the humidity value. To configure the dither matrix, the printer components may scale the dither matrix by applying the humidity value to a response curve.

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Some examples of the invention include the toner cartridge comprising toner, a humidity sensor, and a communication interface. The toner is for the printer system. The humidity sensor detects a humidity level and generates a humidity value that corresponds to the humidity level. The humidity sensor may generate the

5 humidity value to correspond to a humidity range for the humidity level where the humidity range is low, medium, or high. The communication interface transfers the humidity value from the humidity sensor to the printer system.

Description of the Drawings

10 The same reference number represents the same element on all drawings.

FIG. 1 is a block diagram that illustrates a printer system and toner cartridge in an example of the invention.

FIG. 2 is a block diagram that illustrates printer components in an example of the invention.

15 FIG. 3 is a flow diagram that illustrates printer system operation in an example of the invention.

FIG. 4 is a flow diagram that illustrates printer system operation in an example of the invention.

Detailed Description of the Invention

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Printer System and Toner Cartridge -- FIGS. 1-2

FIG. 1 is a block diagram that illustrates printer system 100 and toner cartridge 110 in an example of the invention. Toner cartridge 110 is coupled to printer system 100. Printer system 100 is comprised of printer components 101 and

25 communication interface 102. Printer components 101 are coupled to

communication interface 102. Toner cartridge 110 is comprised of humidity sensor 111 and communication interface 112. Humidity sensor 111 is coupled to communication interface 112.

Toner cartridge 110 contains toner and provides toner 114 to printer components 101 for use in printing operations. Toner cartridge is manually inserted into printer system 100. When toner cartridge 110 runs low on toner, it is manually removed and replaced with a full toner cartridge. Aside from modifications for humidity sensing and communication, toner cartridge 110 could be comprised of conventional components. Toner cartridge 110 could be readily adapted from toner devices that are known in the art.

Humidity sensor 111 detects the humidity level in the surrounding environment and generates humidity value 113 that corresponds to the detected humidity level. Humidity sensor 111 transfers humidity value 113 to communication interface 112. Humidity value 113 could be a humidity percentage or range of percentages. Different humidity ranges could be used as desired. One example of humidity ranges are low, medium, and high where low is 0-25%, medium is 26% - 60%, and high is 61% to 100%. If the humidity ranges are specified by four, five, or six bits, then there can be respectively 16, 32, or 64 different humidity ranges. Humidity sensor 111 could be a conventional component.

Communication interfaces 102 and 112 are comprised of components that transfer humidity value 113 from humidity sensor 111 to printer components 101. Communication interface 112 could be an ISO standard, low-power, short-range transmitter, and communication interface 102 could be an ISO standard, low-power, short-range receiver. Communication interfaces 102 and 112 become operational when toner cartridge is coupled to printer system 100.
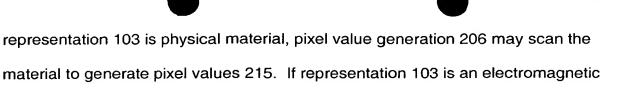
Printer components 101 receive a representation 103 of the desired material

and produce a copy 104 of the desired material using toner 114. Printer components

101 improve print quality by controlling print operations based on humidity value 113.

Aside from modifications for humidity-based control, printer system 100 could be

5   comprised of conventional components. Printer system 100 could be readily

adapted from printer devices that are known in the art, such as the Laser Jet printers

supplied by Hewlett-Packard.

Printer components 101 may include a processor that retrieves and executes

instructions that are stored on storage media. Some examples of instructions are

10   software and firmware. Some examples of storage media are memory devices,

tape, disks, integrated circuits, and servers. When executed by the processor, the

instructions direct the processor to operate printer system 100 in accord with the

invention. The term "processor" refers to a single processing device or a group of

inter-operational processing devices. Some examples of processors are computers,

15   integrated circuits, and logic circuitry. Those skilled in the art are familiar with

instructions, processors, and storage media.

FIG. 2 is a block diagram that illustrates printer components 101 in an

example of the invention. Printer components 101 include humidity value processing

205, pixel value generation 206, dither matrix 207, and copy production 208. Pixel

20   value generation 206 receives representation 103 of the desired materials. Copy

production 208 produces copy 104 of the desired materials. Humidity value

processing 205 receives humidity value 113.

Based on representation 103, pixel value generation 206 generates pixel

values 215 for the desired materials. Pixel values 215 specify the shading for a

25   small area of copy 104. The pixel values 215 may be eight-bit codes. If

representation 103 is physical material, pixel value generation 206 may scan the

material to generate pixel values 215. If representation 103 is an electromagnetic

signal, pixel value generation 206 may electronically process the signal to generate

pixel values 215. Pixel values 215 may even be received from an external source

5   eliminating the need for pixel value generation 206.

In some examples of the invention, printer components 101 produce a

monochrome copy 104 where pixel values 215 only control the shading of a single

color scheme, such as white - gray - black. In other examples of the invention,

printer components 101 produce a color copy 104 where pixel values 215 control the

10   shading of a multiple color schemes. The remaining description assumes

monochrome operation, but those skilled in the art will appreciate how the

description could be readily applied to color operation.

Dither matrix 207 receives and processes pixel values 215 to generate

adjusted pixel values 216. Dither matrix 207 includes thresholds for pixel values

15   215. Dither matrix 207 may turn individual pixels off if their corresponding value

equals or exceeds the threshold; or alternatively, dither matrix 207 may turn

individual pixels off if their corresponding value is less than the threshold.

Copy production 208 receives toner 114 from the toner cartridge. Copy

production receives adjusted pixel values 216. Copy production uses toner 114 to

20   produce copy 104 based on adjusted pixel values 216. Ideally, copy 104 is a high-

quality depiction of representation 103.

Humidity value processing 205 receives and processes humidity value 113 to

configure dither matrix 207 with configuration signal 217. Humidity value processing

205 may use humidity value 113 to select one of multiple possible dither matrices.

25   For example, three possible dither matrices may be available – one for low humidity,

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one for medium humidity, and one for high humidity. Humidity value processing would select dither matrix 207 from these possibilities based on the humidity indicated by humidity value 113. To optimize print quality, empirical measurements could be taken to correlate humidity ranges with their optimal dither matrices.

5   Alternatively, humidity value processing 205 may use humidity value 113 to control the values in a master version of dither matrix 207. In this case, humidity value processing 205 applies humidity value 113 to a response curve to determine values for dither matrix 207. To optimize print quality, empirical measurements could be taken to correlate humidity ranges to optimal matrix values, and the correlation would be implemented by the response curve. It may be desirable to use 16, 32, or 64 humidity ranges if a master matrix and response curve are used.
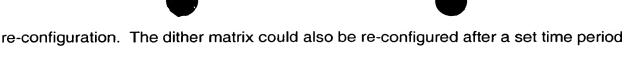
Printer System Operation – FIGS. 3-4

FIG. 3 is a flow diagram that illustrates printer system operation in an example of the invention. If the printer system receives an initial humidity value from the toner cartridge, then the initial humidity value is used to configure the dither matrix. If the printer system does not receive an initial humidity value from the toner cartridge, then a default humidity value that was pre-configured into the printer system is used to configure the dither matrix. Thus, the printer system 100 remains operational if the toner cartridge cannot provide humidity values. Once the dither matrix is initially configured, it is re-configured as new humidity values are received.

Reconfiguration of the dither matrix could occur periodically or in real-time. In a real-time scenario, the toner cartridge and printer system operate continually when powered-up to dynamically re-configure the dither matrix in real-time response to humidity changes. Humidity ranges can be used to reduce the amount of real-time

re-configuration. The dither matrix could also be re-configured after a set time period or after a set number of copies or power cycles – and then only if the humidity value has changed appreciably to warrant re-configuration.

FIG. 4 is a flow diagram that illustrates printer system operation in an example of the invention. When a pixel value is received, it is applied to the dither matrix that was configured in FIG. 3. The pixel value is either turned on or off based on a threshold in the dither matrix. If the pixel value is turned on, it is represented on the copy by toner. If the pixel value is turned off, it is not used.

FIGS. 1-3 and the above description depict a specific example of a printer system and toner cartridge in accord with the present invention. Those skilled in the art will appreciate that some conventional aspects of the printer system have been simplified or omitted for clarity. Those skilled in the art will appreciate that the features described above could be combined in various ways to form multiple variations of the invention. Those skilled in the art will also appreciate variations of the printer system and toner cartridge that fall within the scope of the invention. As a result, the invention is not limited to the specific example described above, but only by the following claims and their equivalents.

What is claimed is:

1. A printer system comprising:

a first communication interface configured to receive a humidity value from a toner cartridge; and

printer components configured to control printing operation based on the

5   humidity value.

2. The printer system of claim 1 further comprising a toner cartridge configured for coupling to the printer system and that comprises:

a humidity sensor configured to detect a humidity level and generate the

10   humidity value to correspond with the humidity level; and

a second communication interface configured to transfer the humidity value from the humidity sensor to the first communication interface.

3. The printer system of claim 1 wherein the printer components are configured to

15   configure a dither matrix based on the humidity value.

4. The printer system of claim 3 wherein the printer components are configured to select the dither matrix from a plurality of dither matrices based on the humidity value.

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5. The printer system of claim 3 wherein the printer components are configured to scale the dither matrix by applying the humidity value to a response curve.

6. The printer system of claim 1 wherein the printer components are configured to

25   use a default value if the humidity value is not available.